The Infrared Integrating Sphere (IRIS) Radiometer for Atmospheric Longwave radiation Measurements

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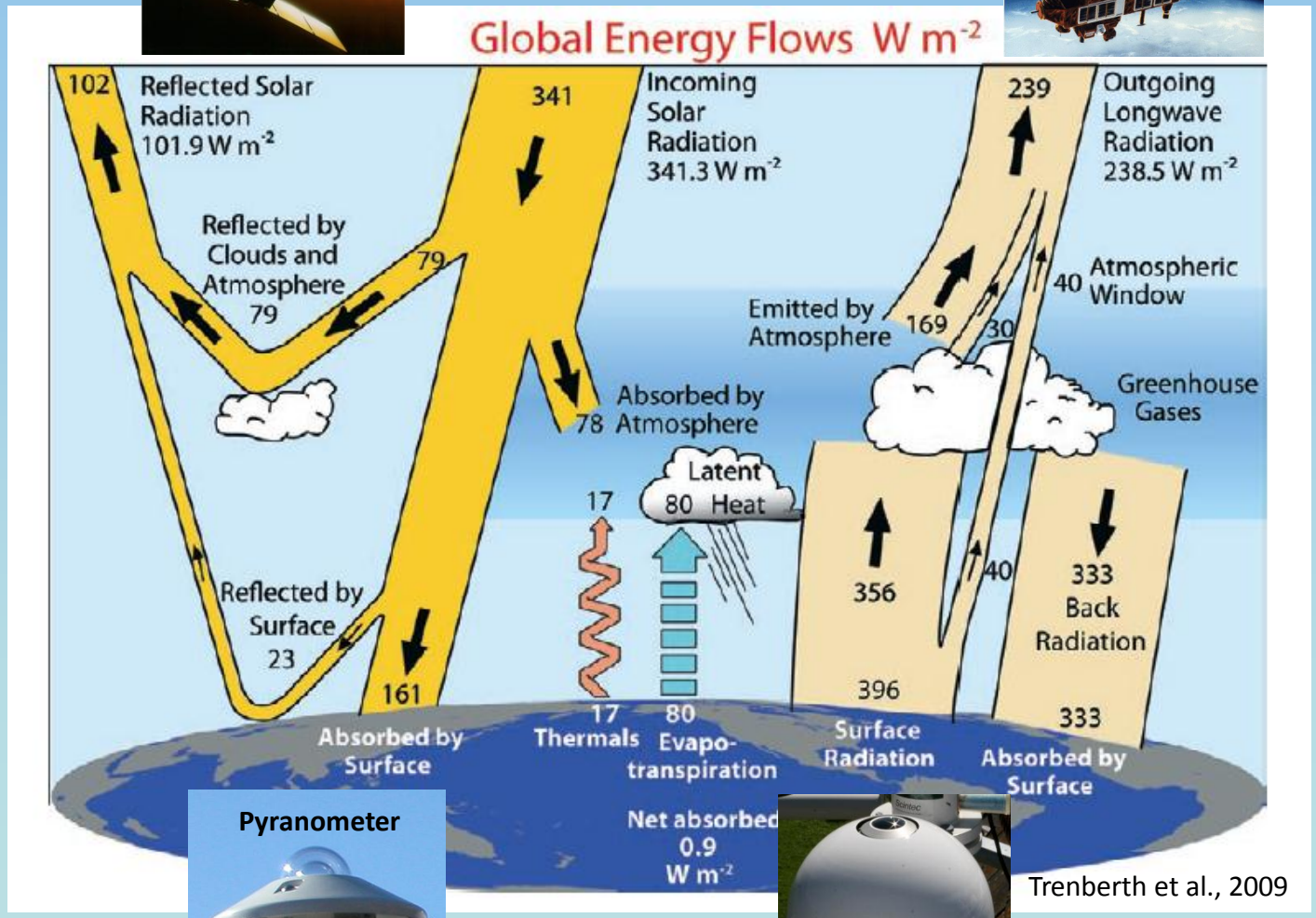
Global Energy Balance



Trenberth et al., 2009

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Traceability to SI units

Atmospheric longwave irradiance is traceable to SI units (Wm^{-2}) using blackbody cavities.

Two <u>independent</u> cavities are operational at PMOD/WRC:

Gröbner, AO 2008

$$\frac{E_{BB2007}}{E_{BB1995}} = 0.99 \pm 0.006$$

Philipona et al., 1995

BB2007 – New cavity built in 2007

- Cylindrical cavity with inclined bottom
- Calculated effective emissivity 0.99993(33)

BB1995 – original cavity built in 1995

- Cylindrical cavity with flat bottom
- Calculated effective emissivity 0.9985

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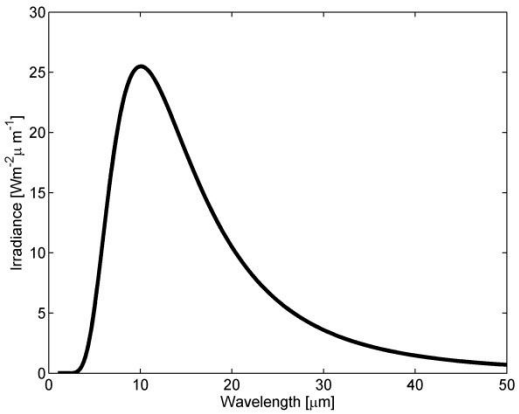
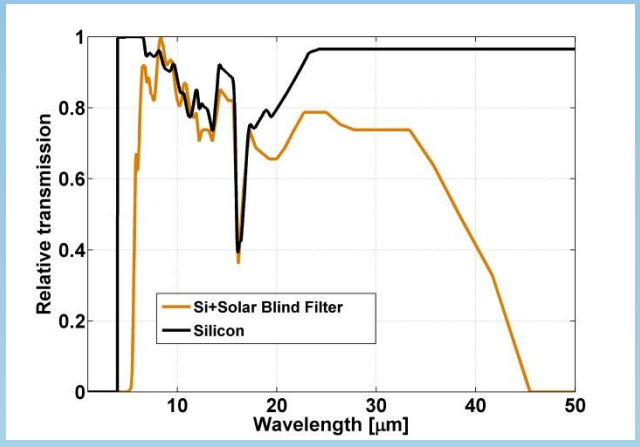
Pyrgeometer Calibrations in a Blackbody Cavity

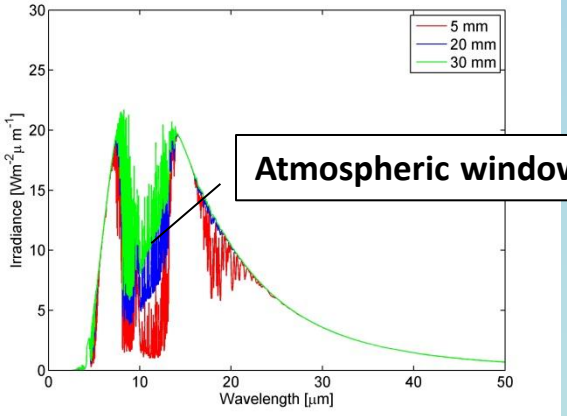
Calibration spectrum



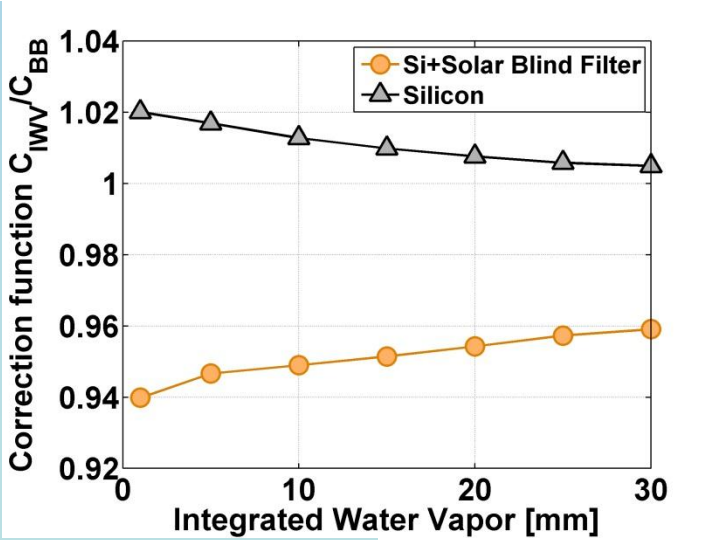
Relative spectral transmission



Atmospheric longwave spectrum



Correction function due to Spectral dome Transmission



Gröbner and Los, 2007

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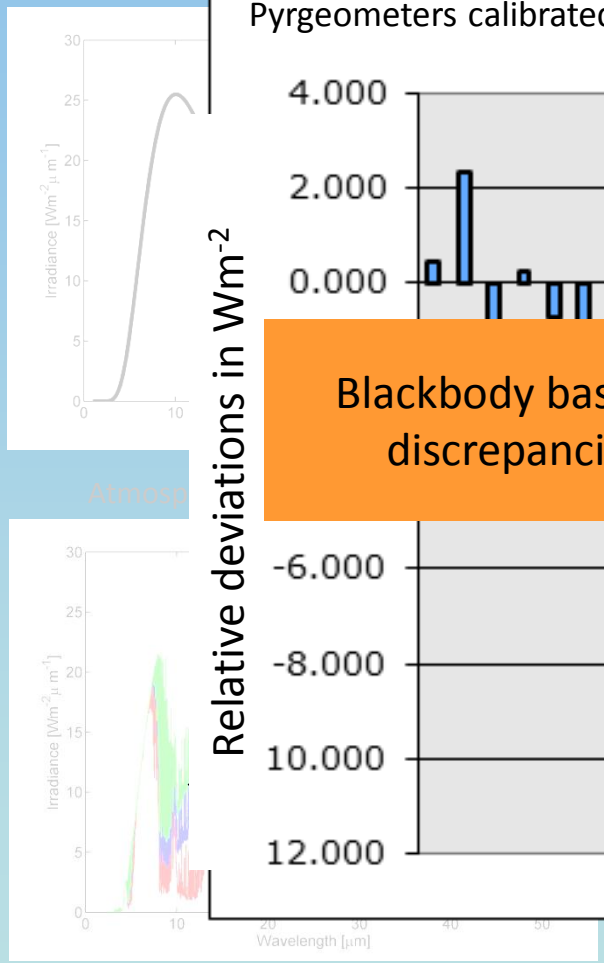
Pyrgeometer Calibrations in a Blackbody Cavity



Pyrgeometers calibrated in the same Cavity showing differences in outdoor measurements

Blackbody based calibrations of pyrgeometers produce large discrepancies in atmospheric irradiance measurements

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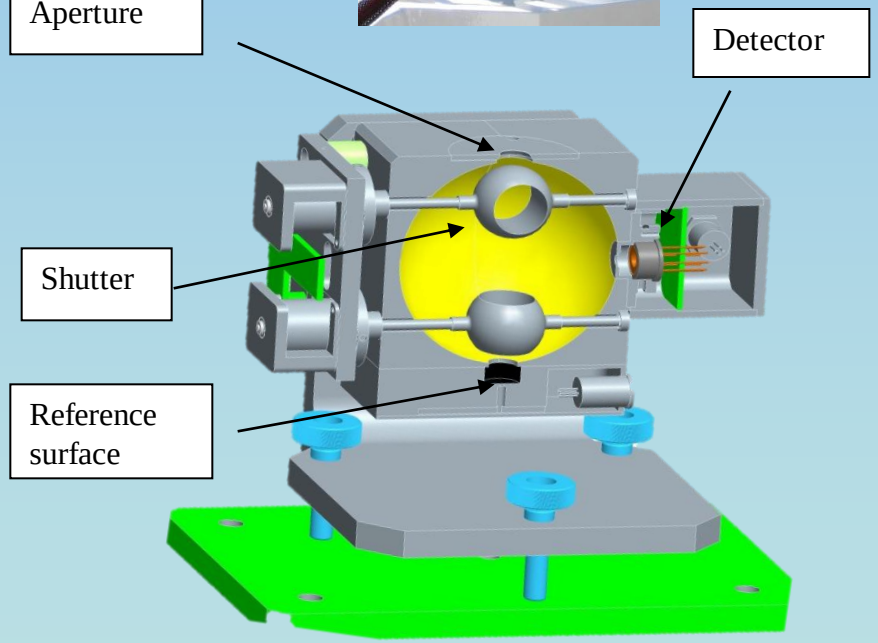
Development and operation of the Infrared Integrating Sphere (IRIS) Radiometer



Key features of the IRIS Radiometer

- **Windowless**
- Irradiance measurement by using a 60 mm gold-plated integrating sphere as input optic
- High sensitivity from a windowless pyroelectric detector
- Flat spectral response
- Measurement frequency 0.1 Hz
- Automatic unattended operation
- Nighttime measurements only

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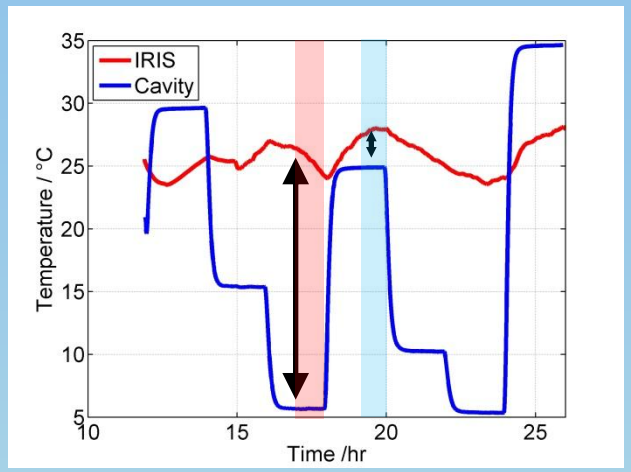
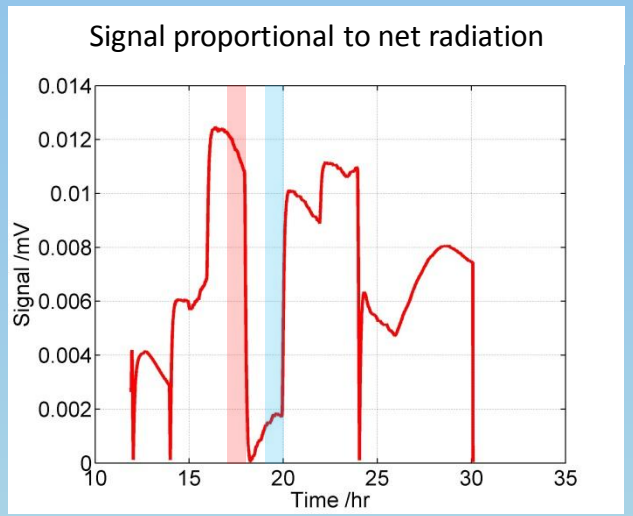
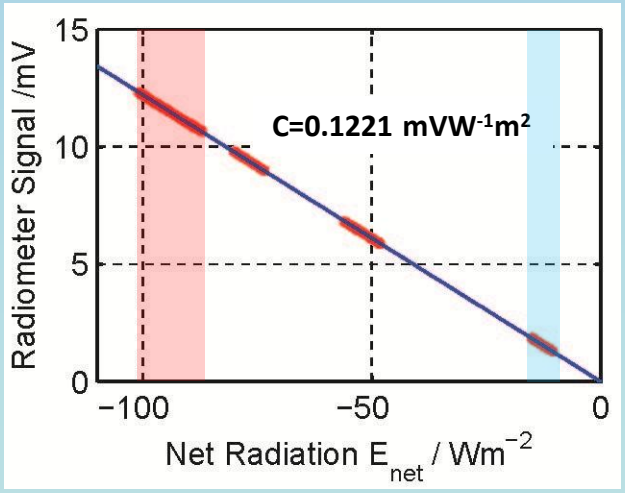
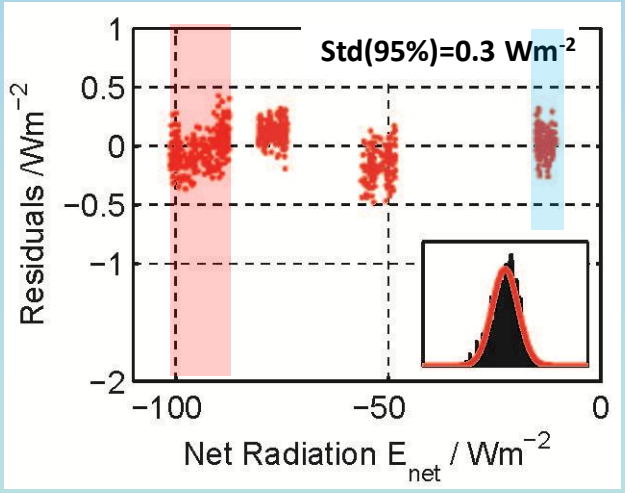
IRIS Calibration in Blackbody





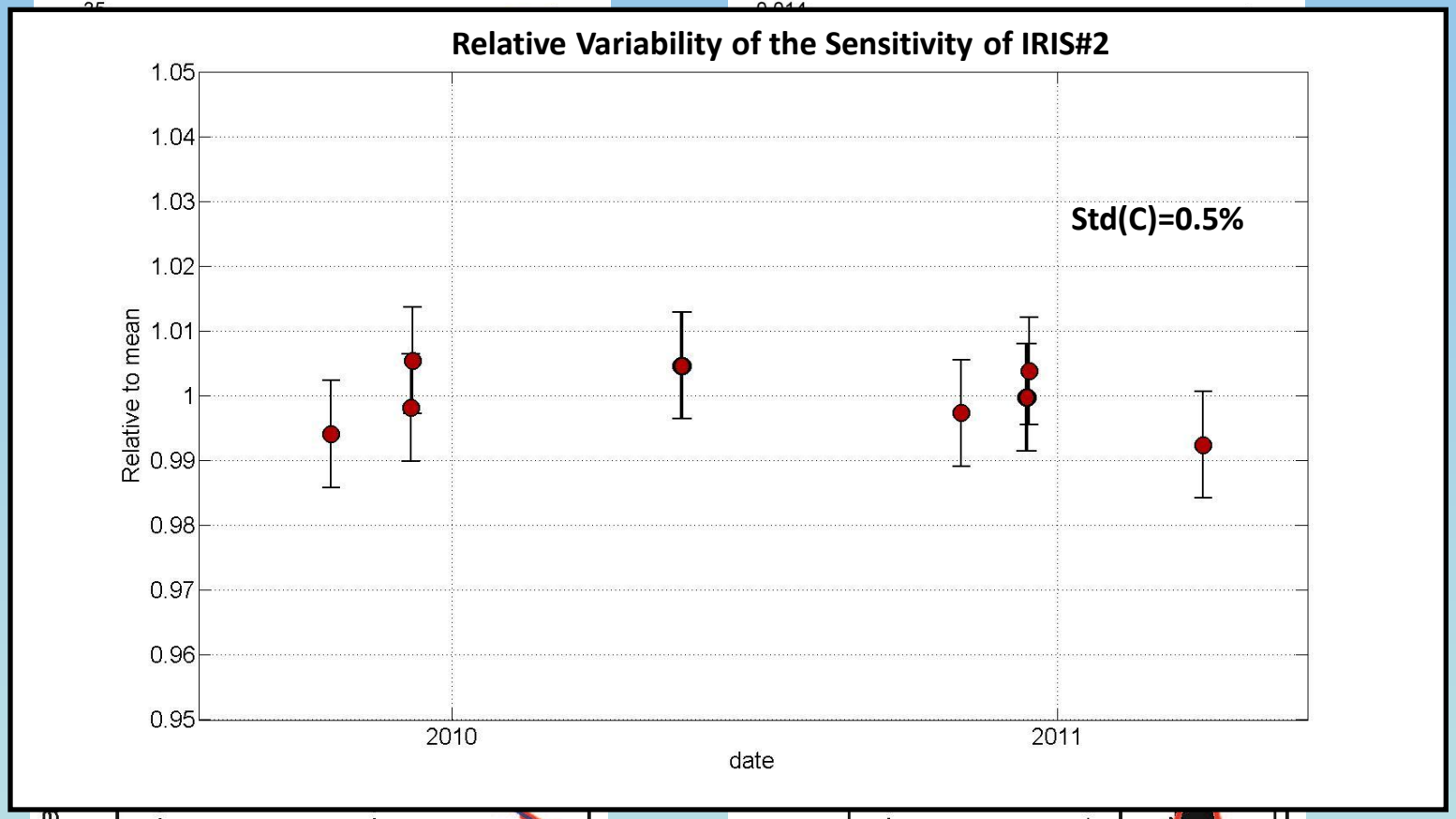
$$U = C \cdot (E_{IN} - E_{REF})$$





IRIS Calibration in Blackbody

Signal proportional to net radiation



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IRIS Uncertainty Budget

Table 2. Combined uncertainty budget for atmospheric downwelling longwave irradiance measured with the IRIS radiometer for winter and summer conditions at Davos, Switzerland. For the determination of the individual uncertainty components, a temperature of either +15° C (summer), or −15° C (winter) is assumed. Furthermore, a net radiation E_{net} component of 100 Wm^{-2}, an upper limit for clear sky conditions, is also assumed to convert from relative to absolute uncertainties in units of Wm^{-2}.

Parameter	Uncertainty [Wm^{-2}]	
	Winter	Summer
Calibration Residuals	0.2	0.2
Calibration reproducibility C	0.5	0.5
Gold collar	0.2	0.2
Temperature correction	0.9	0.1
Signal std. dev. U	0.2	0.2
IRIS reference cavity	0.4	0.6
BB2007 uncertainty	0.2	0.2
combined uncertainty	**1.2**	**0.9**
Expanded uncertainty	**2.4**	**1.8**

The expanded uncertainty is obtained by multiplying the standard measurement uncertainty with a coverage factor k=2, which for a normal distribution corresponds to a coverage probability of about 95%.

U95%= 1.8 Wm^{-2} summer (+15°C)
2.4 Wm^{-2} winter (-15°C)

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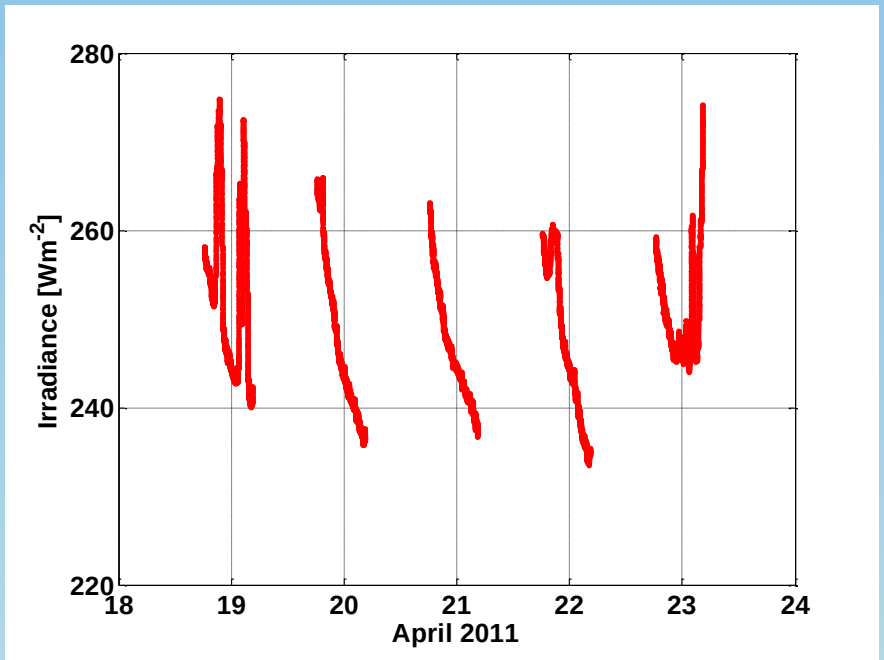
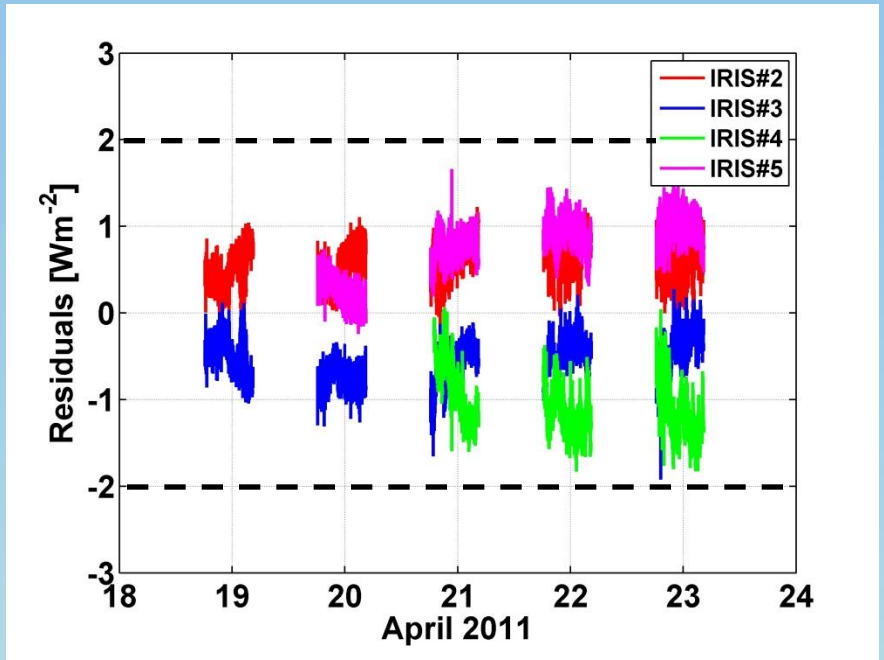
Outdoor comparison in April 2011





IRIS ID	Offset to mean Wm^{-2}	95% Variability Wm^{-2}
#2	0.6	±0.4
#3	-0.6	±0.5
#4	-1.1	±0.7
#5	0.7	±0.7

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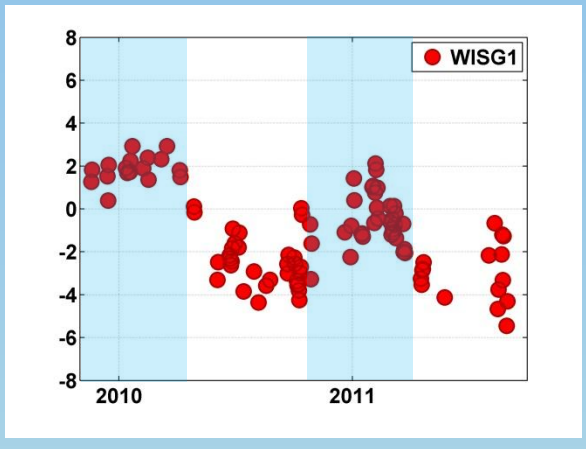
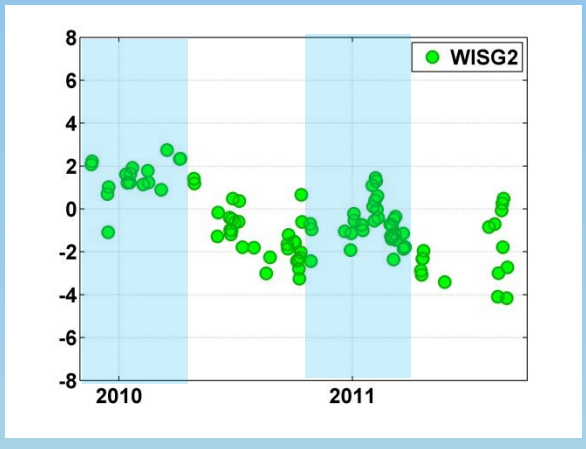
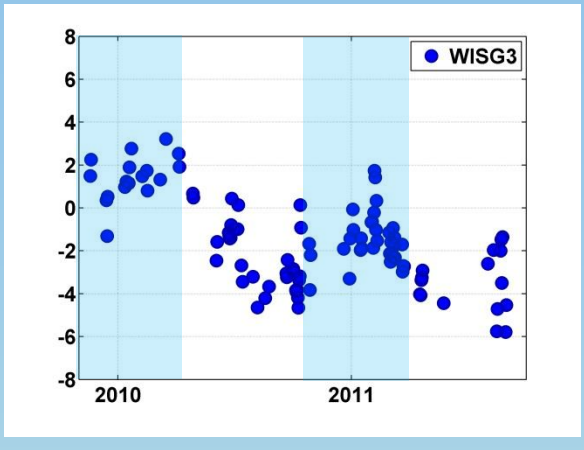
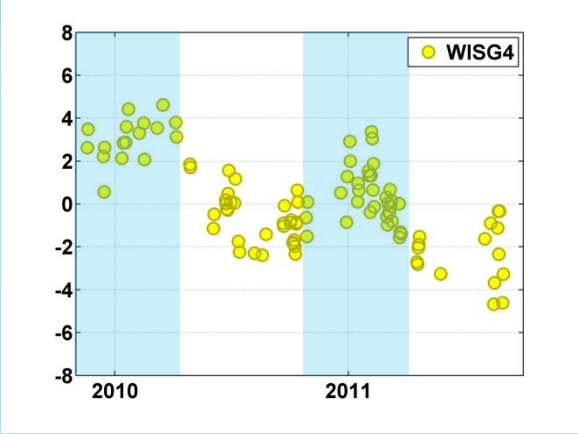
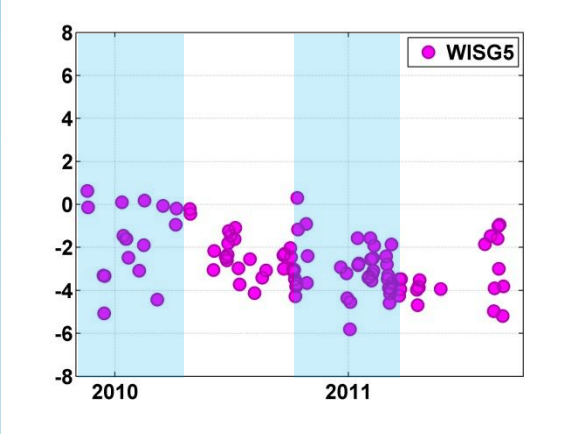
Outdoor comparison to
World Infrared Standard Group of Pyrgeometers (WISG)











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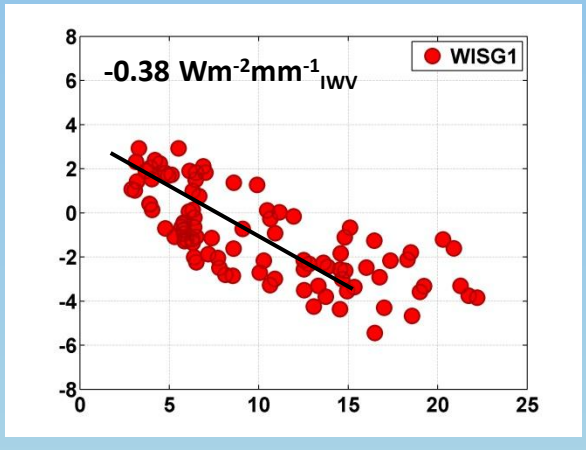

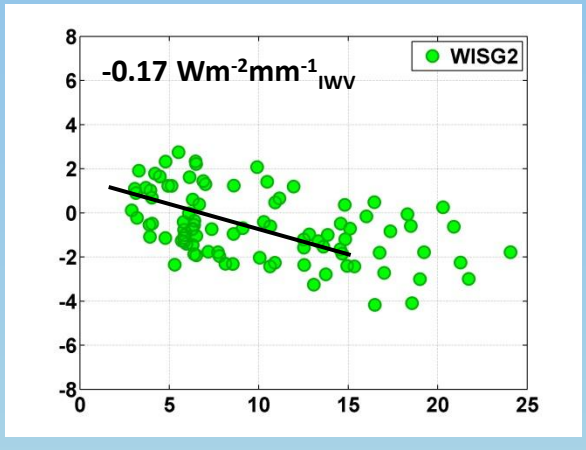

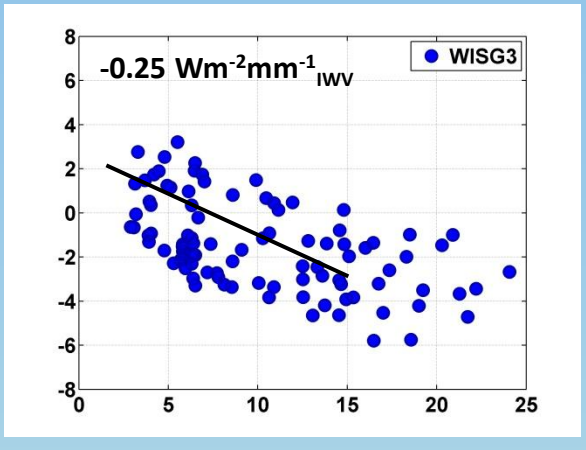

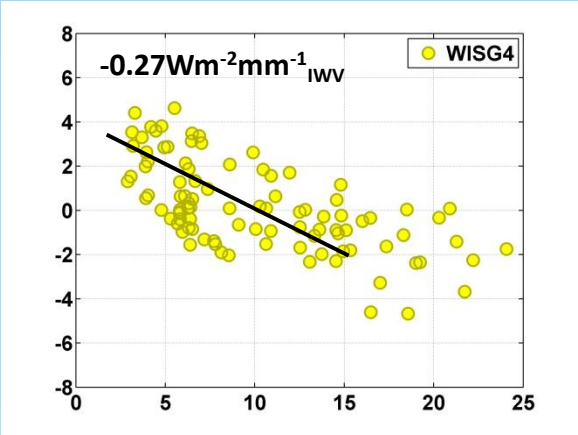

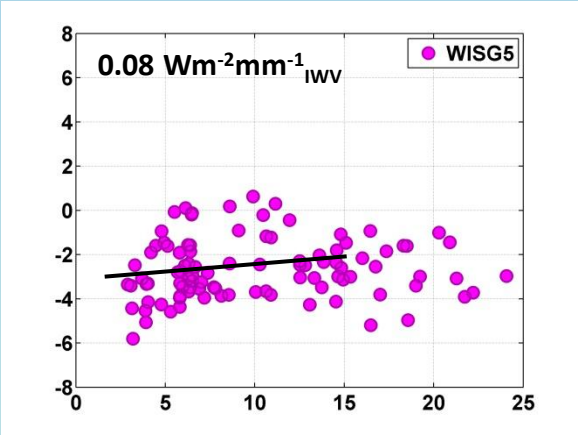

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Conclusions

IRIS Radiometer:

- Validation by calibration with additional Blackbody Cavities.
- Determination of relative spectral Responsivity over 1-50 µm.
- Deployment at additional sites (in progress).

Eventually:

- Comparison to independently calibrated pyrgeometers once they become available.

Goal:

- Establishment of a group of atmospheric longwave Radiometers traceable to SI units.

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